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Team Teaching Implementation in Engineering Education: Teacher Perceptions and Experiences.

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Team Teaching Implementation: Teacher Perceptions and Experiences.

In 2014 Metropolia University of Applied Sciences implemented a fundamental change in its curriculum from small single topic 3-5 credits courses into 15 credits multidisciplinary courses implemented by teacher teams. This paper focuses on how teachers of Information Technology programs experienced the reform. Research data include teacher feedback and opinions that were collected during training sessions and interviews. Team teaching is a substantial change for teachers that raises concerns about time management, getting enough compensation for the work, and possible loss of teacher autonomy. However, teacher teams that managed to overcome these challenges saw a variety of benefits in the new approach. Not only was team teaching seen as a means for providing students with the skills they need, but it also was discovered as a way to enhance the teacher's own professional development.

Keywords: team teaching; teacher collaboration; problem based learning; project based learning

Introduction

Working life is changing due to globalization, networking and technological development. This change is reflected on the expectations of the skills and knowledge of university graduates. Several publications including Davies et al. (2011) and Holtzman and Kraft (2011) have analysed the needs of the future workplace and come up with lists of skills required. Future professionals should be able to use their understanding of complex systems to find new solutions to complex multidisciplinary problems utilising new media for communication while working in a multicultural virtual team. Same requirements are prevalent also in the software industry: It is not enough to be proficient in different design methods, coding and testing; one also needs to have solid teamwork and communication skills.

To develop these newly required skills, education methods and curriculum need to be revisited to give students opportunities to work with real world problems and have the freedom to 'make their own mistakes'. At the same time, education should provide a chance to develop communication skills and emphasize the development of other generic competences (Greiff et al. 2014). Problem based or project based learning (PBL) has been proposed and used as a pedagogical approach that fosters the development of some key 21st century skills such as collaboration and problem solving skills (Berggren et al. 2003; De Graaff and Kolmos 2007).

Multidisciplinary courses built around real world problems provide one possible way of helping students to improve their communication and teamwork skills in an environment resembling the actual work life situations (Davies et al. 2011; Muukkonen et al. 2013). This kind of courses are by definition being designed, conducted and evaluated by a teacher team as opposed to a single subject matter teacher. At many universities teachers are used to being the only teacher responsible for the course and the change required to work efficiently in a team of colleagues is challenging. This change is profound as it is not just a method or single skill, but it actually changes the whole culture of teaching (Vangrieken et al. 2015). Actually, this new challenge for teachers to be able to work productively in collaborative teams is similar to the requirement set by the changed working life for their students. Thus, it is a legitimate requirement for teachers to follow the same practices they expect from their students. There is no one formula that works for every teacher. Instead, teachers should recognize their own strengths and form teams where the weaknesses of individual teachers can be compensated (Sternberg 2005).

For technical universities of applied sciences, the key contribution to the society is training engineers that meet the expectations of the prospective employers. As

mentioned at the beginning of this chapter, working life is going through a fundamental change. The ability to work in teams solving open problems in an organization is possibly the most important skill to possess in working life. In order to encourage this, Metropolia University of Applied Sciences underwent a change in 2014 to adopt a problem-based as well as project-based pedagogical approach. In information technology, the curriculum was changed from small subject matter courses to 15 ECTS (European credit transfer system) modules (Holvikivi et al. 2016). The new curriculum was designed to include a considerable amount of collaborative practices and project work in order to teach not only information technology, but also communication and teamwork skills. The changes implemented are substantial not only for students and course content, but also for teachers. It involves a whole new way of teaching: instead of being the only teacher on a single subject matter course, teachers must work in multidisciplinary teams.

In order to make the transition as smooth as possible, it is important to understand teacher perspective to team teaching and project based learning. This paper discusses how the teachers of Information Technology program perceived and experienced the transition to team teaching of multidisciplinary courses. It also explores what kind of collaboration patterns the teacher teams utilised and what kind of questions should the management be aware of when planning the change.

Team teaching research

This chapter summarizes the existing research on teacher experience in team teaching including definition of team teaching, team teaching as a way to spread best practices, pros and cons of team teaching, and the influence of various epistemic cultures. Finally, the team teaching framework used in this study is introduced.

Defining team teaching

Although team teaching has been applied and studied already in 1970's, there is no single universal definition for it. One way of defining it is as two or more teachers planning, instructing and evaluating the learning of a single group of students (Goetz 2000). It differs from co-teaching as being more comprehensive: co-teaching refers to two or more teachers instructing a multidisciplinary student team in the same classroom. Also, the term collaborative teaching emphasising teacher collaboration and co-operative teaching is used. Instead of defining team teaching based on the number of teachers, their individual roles or teaching delivery logistics, the definition of team teaching should be based on the pedagogical approach and grounded in learning theory (Anderson and Speck 1998).

Team teaching has been proposed as a way to spread best practices and teaching skills (Chopra 2013) and as a vehicle for pedagogical change as it may help spreading new pedagogical practices (Conn 2010). Teacher collaboration in project supervision is not an entirely new concept in engineering education either. Team teaching has been tried out and used in different educational institutions since 1980s. Industry–academia collaboration and innovation projects are long-standing practices in engineering education. In the technical fields, teacher collaboration in R&D (research and development) is well-established. Moreover, projects carried out in international collaboration (such as Erasmus or other EU-funded projects) naturally require teachers from different universities to collaborate. However, these are exceptional cases where teachers are selected according to their interest in international co-operation, and they are not necessarily representative of general teacher attitudes.

Team teaching experiences

Learning as a team is the key for success of any team including teacher teams. Teams should learn about the product, customer and process they are working on to be able to excel and meet their targets. Edmondson (2012) argued that instead of teams and teamwork we should rather think teaming as a verb as it is getting more usual that teamwork is executed in sometimes short lived teams with changing members. According to her, successful teaming requires a working culture where employees feel safe to express conflicting views as well as cooperation and willingness to turn conflicting views into opportunities to synthesize solid solutions to complex problems; an important part of creating such working culture is to make sure that employees feel free to express their views without any fear of being neglected. Kunnari and Ilomäki (2016) studied teachers at a University of Applied Sciences in Finland. The focus of their research was on teacher teams organizing research and development projects for business clients and innovation projects of students. They concluded that existing rigid institutional structures and practices can be a serious hindrance to efficient teamwork.

Vangrieken et al. summarised, based on a large number of studies, that 'The long-standing culture of teacher isolation and individualism, prevalent conflict avoidant and non-interfering behaviour of teachers together with a wish to preserve their individual autonomy may withhold a more collaborative culture to rise in education' (Vangrieken et al. 2016, 7). They surveyed a large number (105) of vocational teacher teams but the teams were called entitativities by the authors because of their loose collaboration. They suggested that gaining teamwork experience by working regularly in teams should be part of teacher training programmes.

However, while team teaching forces the staff to break from the isolation, it at the same time gives them the opportunity to get direct and honest feedback and support from peers (Goetz 2000; Helms et al. 2005; Baeten and Simons 2014). Furthermore,

team teaching is seen as an opportunity especially for junior staff to learn from more experienced peers (Nixon et al. 1997; Helms et al. 2005; Baeten and Simons 2014). Team teaching helps in creating collaborative atmosphere and encourages active participation (Anderson and Speck 1998; Huisheng and Gao 2013). When practising team teaching, multiple viewpoints for learning emerge (Helms et al. 2005), as students are exposed to academic debate between professionals (Anderson and Speck 1998). The downsides of team teaching are mainly related to the fact that it requires more time for planning than individual teaching (Wenger and Hornyak 1999; Goetz 2000; Helms et al. 2005; Baeten and Simons 2014). Team teaching requires solid teamwork skills (Baeten and Simons 2014). Furthermore, fair and consistent assessment of students on such a course is not trivial (Helms et al. 2005). Experiences on success and failure in implementing team teaching suggests that best way to get the buy-in for team teaching is to get teachers to experience team teaching before committing to it (Joyce 2004).

One factor affecting teamwork in teacher teams is epistemic cultures that vary in different fields of science. Knorr Cetina (2009) undertook a ground-breaking study when observing and comparing epistemic cultures in two fields of science, namely high-energy physics and molecular biology. She defined epistemic cultures as referring 'to different practices of creating and warranting knowledge on different domains' (Knorr Cetina 2009, 246). The term can also be applied to expert cultures outside science. The fields that she studied can be characterised as the communitarian and impersonal science of physics, and individuation and the experiential conception of measurement in molecular biology labs. In this study, we expected challenges based on Knorr Cetina's findings when integrating subjects and their teachers from domains that have different epistemic cultures, such as engineering and language/communication or mathematics.

Team teaching framework

Wenger and Hornyak (1999) described in their paper a motifs-based team teaching framework. They divided the team teaching motifs into three categories: sequential, distinctive and dialectic. In the sequential motif, teachers divide the topics and give sequential mini lectures followed by practical assignments. In this motif teacher's authority is high and the learning objectives are knowledge and comprehension of the topic area. In the distinctive motif the topic area is divided so that some teacher team members concentrate on the theory while others concentrate in the practice with more emphasis to application and analysis. In the dialectic model the objective is to encourage debates and demonstrate professional disagreements and dealing with them. Dialectic motif emphasises synthesis and evaluation through debates and helps the students to learn how to deal with open questions and uncertainty. We decided to use this framework to frame our findings on teacher collaboration patterns applied by the teacher teams.

Teacher experiences and perceptions require further research

Team teaching is not a new idea and it has been tried out and implemented in a number of educational institutions. However, based on the literature research it seems that teacher experiences and perceptions have not been studied to the same extent as student experiences especially when it comes to the actual transition from traditional lecture-based teaching to student-centred methods and collaborative project-/problem-based pedagogy including team teaching. The aim of this research was to explore teacher perceptions and experiences of teaching in teams and identifying useful practices that could be applied in transformation from a traditional one teacher/one course model to a teacher team teaching a multidisciplinary course. The question can be studied from several viewpoints: teachers participating in team teaching, teachers who

have not yet been involved with team teaching, collaboration patterns used and managers' views on team teaching.

Research questions

The purpose of this paper was to analyse teachers' perceptions on the curriculum change involving team teaching at Metropolia University of Applied Sciences and find an answer to the main research question: What should be taken into account when planning change from individual teaching model to teacher teams? The main question is answered through the following sub-questions:

(1) How was the impact of the curriculum change perceived and experienced by the teachers?
(2) How did the participants of a teacher team describe the benefits and challenges of multidisciplinary co-teaching?
(3) What kind of collaboration patterns were applied by the various teacher teams?
(4) What kind of questions degree program heads think the management should be aware of?

Design and Methods

Research approach

The data collected and analysed in this research is versatile and contains interviews as well as ideas collected in various meetings and events. The study is an explanatory building case study where qualitative and descriptive methods are applied in data collection and analysis (Yin 2013). This approach was selected because it is suited to answer the "how" type of research questions in a setting where the researcher had very limited control over the events studied and the study is about a contemporary

phenomenon in a real-life context.

Context: Teacher teams, Curriculum development and alternative module designs

The Universities of Applied Sciences have the role of providing higher education that is less theory and research oriented compared with science universities. This being the target, the courses typically involve more practical tasks than similar courses in science universities would involve. Furthermore, universities of applied sciences are usually more tightly cooperating with local companies than science universities.

Metropolia University of Applied Sciences, largest University of Applied Sciences in Finland, provides education for students in the areas of Business, Culture, Health Care, Technology and Social Services. Finnish Universities of Applied Sciences adopted a new performance-based funding model between 2013 and 2015, where the funding is heavily dependent on the number of students achieving the target of 55 ECTS during an academic year. To reach this goal a fundamental curriculum reform was adopted: all small, topic centred courses were transformed into larger 15 ECTS multi-disciplinary modules. At the same time the organisation was changed into competence based model consisting of 17 competence areas organised in four business divisions. Each business division had several degree programs. This study discusses the students of Information Technology programs.

Although CDIO (Conceive, Design, Implement, Operate; De Graaf and Kolmos 2007) was partially implemented already in 2005, the number of courses applying CDIO in Information technology before the curriculum reform (in 2013) was limited to a few courses. For instance, the first-year studies in information technology consisted of 30 different small courses. After the financing of Universities of Applied Sciences became greatly dependent on the number of students achieving 55 ECTS in a study

year, it became obvious that with the current pedagogical model that target would not be achieved. Furthermore, the current model failed to support the development of 21st century skills: a change to larger interdisciplinary project-based courses was selected by the management to be the way to proceed.

The new learning track was to be composed of applicable project based multidisciplinary courses with the aim of developing student's problem solving and communication skills on top of the core professional skills. Such modules were targeted to increase student motivation and improve student retention.

After the reform the studies in information technology degree programme were divided into four 15 ECTS modules per year. General studies such as mathematics and language studies during the first semester were combined with basics of core professional studies. Each module during the first year had a unifying theme namely networks, mobile solutions, game development, programming and web-development, electronic devices and object-oriented programming. The project work in each module was supported by a varying amount of basic and theoretical studies such as mathematics. Each theme was taught by a teacher team of 5 to 7 teachers who had a considerable degree of freedom when planning the implementation.

Altogether 27 teachers participated in the teaching of the first-year students on one campus. Out of the 27 teachers, 19 were professional studies teachers, four communications teachers, and five mathematics and physics teachers. Mathematics and physics teachers participated in many teacher teams whereas the professional topic teachers participated only in a single team. During the study year 2014-2015 each module was run four times totalling 16 implementations. The reform and modules are described more in detail in Hjort et al. (2015) and Lukkarinen et al. (2015).

Teaching of engineering curriculum involves several professional groups as teachers. In this particular case, there were science teachers (mathematics and physics), language teachers, and particular information technology professions. Mathematics and physics were until 2008 formerly united to their own department that offered teachers to degree programs. Similarly, there was a separate language centre. This encouraged the retention of respective professional cultures, and the planning of courses from each discipline's internal logic.

These professional groups hardly intermingled, as the curriculum was organised in small individual courses and modules, and the major subjects were kept apart from each other. A drastic change took place when two colleges in the capital area merged, and successive reorganizations were implemented. Together with the curriculum reform in 2014, a major overhaul in the organization was done in order to mix and bring various disciplines closer. These changes effectively broke the lines between professional sub-teams and forced new ways of collaboration.

Participants and data collection

Participants for this study include the teachers who taught the first-year students during study year 2014-2015, teachers who participated in training events around team teaching, and degree program heads. We collected their ideas, experiences, concerns and questions about the change in various training events, teacher feedback sessions, department (an organisation unit that is responsible for a few majors in a certain area of expertise) meetings and heads of degree program's workshops. Training events had around one hundred participants whereas the department meetings had each 5 to 10 participants and the teacher workshops around ten participants. Every participant of the teacher workshop had been practising team teaching whereas only a few participants of the training events had practical exposure to team teaching. Department meeting

participants were mostly managers and some of them had practice in team teaching. We also interviewed a teacher team at the end of the study year and utilised field notes and meeting minutes of a teacher team. Table 1 summarizes the data sets described in more detail in the following chapters.

[Table 1 near here]

Notes of teacher perceptions and experiences from training events and meetings

At Metropolia University of Applied Sciences, the process to support team teaching implementation involved training events, feedback sessions and department meetings. The training sessions had around hundred participants. Some but not all teachers in the audience had personal experience in team teaching on a multidisciplinary course. During the sessions, the concept of multidisciplinary courses with some concrete examples were introduced. After the introduction, concerns on team teaching were collected from the audience with a digital idea mapping tool (flinga.fi). A screen capture and an excel spreadsheet export of the data were created.

Teachers of all modules had common feedback sessions where the solutions and problems were discussed and compared. Three facilitated workshops for teachers participating in the first-year teaching was arranged during the semester to collect experience and ideas for improvement. In all, 20 out of the total 29 teachers participated in at least one workshop.

Discussion in teacher team feedback sessions was facilitated around the following questions:

(1) What things comprise a well-functioning teacher team?

(2) How could mathematics and physics be integrated with professional topics?

(3) How could we make a transition from content centric teaching to skill and knowledge centric teaching?
(4) What is motivating, supportive and instructional assessment like?
(5) How could one make a solid timetable for a module?

The questions address the main challenges experienced in teacher teams: teamwork, integration of topics, scheduling and the transition from one teacher led teaching to team teaching. The study advisor made notes on these sessions and wrote summaries of the conclusions and recommendations.

During the first half of 2015, we also visited the department meetings. In these meetings, the team teaching concept and some experiences were presented, and after the presentations there was a discussion where the concerns and development ideas of the audience were captured on meeting notes. After the meeting the notes were documented in a Google document.

Interview of a teacher team

Teachers participating, in varying combinations, in the implementation of one set of modules (7 people) were interviewed by an external researcher through a semi-structured group interview. These teachers were selected to participate in the research as they applied the integrated module approach in the module implementation. The interview questions focussed on the successes and positive aspects as well as on challenges and failures in implementing the modules and organising the team teaching. The interview was recorded and transcribed verbatim.

Study program implementation documents and participant observations

In addition, various documents (timetables, planning documents, meeting memos etc.) and participant observations of the three authors of the article (discussions, classroom

observations etc.) were used as data to examine team teaching collaboration patterns in the study programs. The schedule for the first-year students was saved from the universities schedule system as a pdf-file for each study week. Data about the modules was also collected through field ethnography and participant observation (Spradley 1980; Green and Bloome 1997).

Heads of degree program workshop

In August 2015, we had a workshop for the heads of degree programs, where the questions about team teaching were captured. The meeting had 25 participants, which were divided into three teams each having a facilitator to document the questions on flip charts. Each team was given the task to think about questions for a specific organizational entity:

(1) Headmaster, directors
(2) pedagogy development team
(3) Heads of departments
(4) Lecturers.

The teams rotated through all tasks, so that all participants had the opportunity to give their feedback on each topic. The idea was that the questions would reflect the concerns of the workshop participants regarding team teaching. The questions were written from the flip charts into a Google spreadsheet.

Data Analysis

Data collected for this study is qualitative: ideas, questions and concerns collected from various workshops, training events and teacher interviews. In order to find and analyse the common themes related to teacher perceptions and experiences of team teaching, we

applied a combination of thematic analysis (Braun and Clarke 2006) and qualitative content analysis including quantification of data (Chi, 1997). Thematic analysis is useful for identifying common themes within and across data sets. With quantification, we aimed at more systematic examination of qualitative data for unfolding some trends and patterns in the data for descriptive interpretation. Qualitative data sets were segmented into units or statements, each of which was considered to represent a separate idea. Each unit was categorized only in one theme. Two researchers cross-analysed the data sets and agreed on the final sets of themes that were used to analyse all these four data sets. Those cases in which discrepancy emerged were encoded according to mutual agreement.

The data sets Training Events, Teacher feedback sessions and Department meeting notes were combined for analysis to answer the first research question. The statements collected were printed on paper and labelled with the data source. Papers were cut in pieces that each had one statement and they were put on a table for sorting. An iterative process was applied to find themes in the data by first assigning data items under initial codes. In the second phase, some of the codes were combined to form themes and some were discarded. Themes were identified at an interpretive level as our aim was to understand the underlying ideas, assumptions and ideologies.

For the second research question, analysis of the teacher group interview transcriptions was conducted by the researcher applying the same preliminary categories as in the previous analysis, but adding new categories in a data-driven manner. Those excerpts from the interview answers were selected for coding, in which the participants somehow evaluated the successes and challenges; answers where they just described the modules (goals, tasks etc.) without evaluation, were not included in the analysis. The analysis was conducted using Atlas.ti software (version 7.5.10).

The themes found in the analysis of the interview were compared with the themes of the first analysis. Two researchers cross-analysed the data sets and agreed on the final set of themes that was used to analyse all these four data sets. The final themes are described in Table 2. Finally, each statement was also categorised according to whether it represented a positive (benefits, successes etc.) or negative (challenges, failures etc.) viewpoint to the issue.

[Table 2 near here]

To answer the third research question, timetables, planning documents, meeting memos of feedback sessions, teacher team interviews and discussions with individual teachers were used as input to create a categorization to the way team teaching was applied in the various implementations of the 15 ECTS courses. Team teaching framework proposed by Wegner and Hornyak (1999) was used as the starting point for the analysis, but the final classification was done in data-driven manner based on all data. We looked for data items in these sets related to the level of integration and on the other hand the co-operation mode of the teacher team in order to be able distinguish collaboration models used. Based on the co-operation mode and collaboration model the courses were divided into three categories.

For the fourth research question, notes from the degree program heads' workshop were analysed. Questions of team teaching were firstly grouped based on the organizational unit they were targeted at. Secondly, they were grouped using descriptive coding based on the kind of topic they were addressing in these groups: leadership, management and concern.

Results

This chapter provides an overview of the results gained by analysing the six data sets used. Firstly, content of discussions in teachers' training events and meetings is

explained followed by chapters for Experience of a teacher team collaborating in a set of modules, Collaboration patterns in the implemented modules and questions raised by degree program heads.

Content of discussion in teachers' training events and meetings

Table 3 summarizes the frequency of themes in the data sets (#data units is the number of ideas/questions/concerns identified in the data). The three most frequent themes in each data set are bolded.

[Table 3 near here]

The attitude -theme contained worries about teacher's motivation in participating in theme teaching, teamwork skills of teachers, worries of changing work content and teachers being different phases of adoption to team teaching. *Integration theme* included concerns about integrating mathematics and physics to professional topics whereas integrating English communications to the courses was seen as a straightforward thing. *Presence -theme* included of suggestions for practices in handling student absence from the class. Some called for strict control and taking early actions if a student is absent too often. *Resources* -theme included mostly items related to the worry that the compensation for more work caused by teamwork would not be compensated. *Quality -theme* included concerns about getting course credit too easily on a multidisciplinary course built around a project and how to make sure that student efforts are evaluated in a coherent manner across all modules. Positive comments in the quality included observations that student motivation seems to be higher and social skills of students improve on a multidisciplinary course. Most of the comments in *Resources -theme* were related to time allocation and management. Many respondents thought that there would not be enough resources allocated to designing the course

implementation and handling the coordination and communication required in the team teaching setup. Student collaboration theme included concerns about free riders, but also observations that team work by students creates positive pressure on the peers. *Study program implementation* -theme concerns were about how to organise resits for courses, how to handle late comers to the courses, would students be overwhelmed by the amount of team work and will individual performance be adequately credited. *Teacher collaboration* -theme concerns were related to unifying methods and procedures across modules, how to define responsibilities related to grading of the courses, where are the limits for teacher autonomy and how to find time for meetings and travel between the campuses.

Interestingly, the biggest themes in training events were attitude and resources, which were not prevalent in the teacher workshop. One possible reason for this is that the training events' participants included mostly teachers not involved in team teaching whereas the department meetings' and teacher feedback sessions' participants included almost exclusively teacher and managers involved with team teaching.

Training events data set included only one single positive comment (rest were neutral or negative): 'We are witnessing a revolution in tertiary education. We are starting to work in teams: a change that has happened in other business already a long time ago'. The lack of positive comments is possibly a manifestation of resistance to change and fear of losing teacher's authority and autonomy. The other two data sets include almost the same number of negative and positive data items.

Experiences of a teacher team collaborating in a set of modules

A team of teachers responsible for the same set of modules was interviewed. Table 4 provides a summary of the analysis. Both positive and negative aspects of the pedagogical implementation and teacher collaboration were explicitly asked in the

interview.

[Table 4 near here]

All statements related to the *teachers' attitude* towards the change were positive. Language teachers described that it was very impressive and rewarding for them to finally see 'what engineers really do', and to participate in authentic project work practices. The participants also mentioned that it was interesting and useful to see other teachers' teaching methods, and to discuss about pedagogical problems and solutions together. One teacher thought that they learned also more from the students in this new type of modules than in previous courses, because collaboration with them and presence in the classroom was more comprehensive.

Integration of subjects received equally much positive and negative evaluations. The integration succeeded well between professional subjects and language and communication subjects. For example, the students made some parts of the project work in a foreign language, which was felt as a good solution because now the language was used in a real context, not studied separately with arbitrary tasks. However, the integration of mathematics and physics teaching in the students' project work did not actualize, and the interviewed teachers discussed whether it is even realistic to achieve such integration in the first-year studies.

Methods were discussed a lot in the interview. Positive aspects related to the benefits of group and project work for students ('If the work happens in their own project group, it is more productive moment than working alone or in the whole class'), or to successes in team teaching and guidance. The interviewees thought that team teaching was beneficial for students for several reasons: e.g., students saw one model of professional collaboration, students received feedback and guidance from multiple teachers, and the progression of project work was better taken into account when many

teachers were aware of the situation. Problems and challenges included various methodological issues: laboriousness of project work for students, organizing groups, problems with lecturing and whole class discussions, and especially the challenges in finding good ways to guide group work. For example: ‘Particularly the solving of conflicts, actually I think that it is something in which we would need some training ourselves; how the solution of conflicts takes place. I do not have any range of instruments for that.’

Concerning the *quality* of teaching/learning, positive statements emphasised that the goals of the new curriculum were achieved, students learnt more or different things than students in the old curriculum, and students had succeeded even better than expected (‘Especially the groups that were very active; I think that they learnt an awful lot of things that cannot be taught in any lecture.’). Negative aspects concerned students who have major problems in this type of studying because of personal constraints such as lack of self-regulation or social ability, and the fatigue of all students during the last spring module.

Resources were discussed very little, all comments related to problems with the burden of the new practices for teachers’ work; e.g., when the curriculum extends to second grade students next year.

Student collaboration in groups emerged one issue in the team interview. Positive comments included descriptions of successful group practices and collaborative atmosphere (‘How they started to take responsibility of each other and how they started, in a way, not to compete, but their motivation to go forward and develop become better, in some groups it showed incredibly well.’). Negative statements focussed on insufficient communication or participant contribution in student groups.

Study program implementation was somewhat discussed in the interview. Positive aspects related to the synchronization of content in successive modules and the agile planning of teaching in each module based on the progress of students' project work; for example: '... who is [responsible] at any given time, and then we, however, dealt with the content in terms of the group'. Negative statements concerned challenges in timing and scheduling of the modules.

Teacher collaboration was mainly discussed in positive terms. The planning of new modules was done in the preceding spring with some joint meetings. When the modules started in autumn, separate meetings were not felt necessary because the teachers met often enough in the class where the common group of students worked full time. This solution of having a "home class" for the student groups throughout the module eased also teacher collaboration without extra arrangements. A few negative comments concerned some disagreements in course planning. In addition, one teacher (who was not in the interview) joined the team late, and there had been difficulties in involving him in the collaboration, because there were no established joint meetings.

Collaboration patterns in the implemented modules

The modules implemented according to the new curriculum structure had various designs and arrangements for teaching. Each theme had a teacher team of 5 or 6 teachers who had a considerable degree of freedom when planning the implementation. Therefore, the ways that subjects were integrated varied a lot between teacher teams. The implementations were classified as follows:

(1) *Separated parts under an umbrella*. Some implementations actually consisted of almost separate parts. Some teacher teams simply decided to continue they

earlier courses under a new umbrella, and the 15 ECTS module was divided into three 5 ECTS disconnected parts that were assessed separately.

(2) *Partially integrated module*. Many implementations had a separate unit for mathematics and/or physics, and the professional content was more unified, even though media and programming tools or laboratory measurements were taught separately. Usually, however, there was a common project for students. The evaluation consisted of several components that were summarised.

(3) *Integrated module*. Apart from the separate science classes, all professional and language content (communication skills) was integrated, and teachers collaborated in theoretical subjects and project work. Deliverables such as presentations and project documentation, were assessed both from substance and communication aspects.

If one looks at the module implementation through the Wenger and Hornyak (1999) team teaching motifs, most of the time the team teaching motif was sequential (8 modules). Based on the interviews and our own experience there were only few examples (4 modules) of the distinctions motif or the dialectic motif. Considering the fact that most of the teachers involved with these courses were practising team teaching for the first time, this was actually expected to be the case.

These three patterns included a different amount of co-operation, and co-teaching was present only in the third pattern. In the second and third pattern, some types of lessons always had more than one teacher present. These included also student team presentations where most teachers were listening, giving feedback and jointly evaluating the learning outcomes.

Interestingly, the second pattern seemed to be the most burdensome for teachers, even though it was the most commonly applied. In Finland, teachers at Universities of

Applied Sciences have a fairly heavy workload of contact teaching (20-25 hours per week), and therefore they have to shuffle from class to class daily. They could not concentrate on one module at a time. In the partially integrated pattern, they had to spend quite a lot of time in coordination and planning meetings, which they found arduous.

In the third pattern, teachers were sometimes present in the classroom at the same time. Depending on the phase of the course, and student needs, there were one, two or three teachers advising and helping. Sometimes students wanted to work independently and required no teacher presence at all. This third pattern actually eased the workload, as all teachers were quite well aware of the situation in the classroom, and next steps in projects could be discussed during classroom sessions. Almost no extra meetings were needed, except for evaluation discussions. One additional advantage for students was the choice of instructors whom to approach. Because teacher teams included men and women, younger and older teachers, students could ask for help from the person they felt comfortable with.

Therefore, the ways that subjects were integrated varied a lot. Some implementations actually consisted of quite separate parts, whereas others had a larger unified project assignment. This was mainly due to the conditions for planning, because very few extra resources were allocated to the implementation of the reform. Some teacher teams simply decided to continue their earlier courses under a new umbrella.

Questions raised by degree program heads

Table 5 summarizes the themes (leadership, management, concern) identified by analysis of the head of degree program's workshop including data examples.

[Table 5 near here]

More than half of the questions captured in the workshop fell under the *leadership* theme and are mostly related to motivating and involving teachers: How to involve all teachers? How can we create standard operating procedures? Am I acting as an example to my colleagues and teachers in my team? Are we utilising students and their energy in planning and implementation?

Second most frequent theme was *management*, in which the questions were centred around scheduling, planning and resourcing issues: How responsibilities are defined? How can we ensure that decisions get implemented in every part of the organisation? Is there still enough work for every teacher? What shall we do with teachers that decide not to join in team teaching? How find balance in resourcing for R&D, customer projects and team teaching?

Third theme was *concerns*, which included for instance questions related to teacher autonomy and possible pros and cons of team teaching from students' perspective: How can I fit my course content into smaller amount of time? Could it be that student actually want more traditional teaching methods?

Discussion

Curricula at universities, including ours, often consist mainly of one-instructor courses, or courses run by a senior professor and young assistants or tutors. There is ample evidence that the resistance and unwillingness for curriculum changes is strong all over the world (Wall 2010). Similar concerns and resistance was found in the present study. Teachers were concerned among other things about teacher autonomy, attitudes of colleagues and lack of time. Also, teachers' superiors seemed to have similar concerns. However, based on the present study it seems that the more one practises team teaching the less concerns there are, which is in line with findings of Joyce (2004).

Especially in the Training events data, attitudes had a big share (30% of all data units) and all comments except one were negative. In the interview with teachers who had implemented new modules, all attitudes were positive, which is encouraging. Also worries concerning resources were a big issue in Training events (22% of all data units), but in the teacher team interview they were not discussed. Also study program implementation emerged as major themes in teacher training events and teacher feedback sessions before/during curriculum implementation but in the interview of a teacher team after the implementation, it did not emerge as a big issue.

Team teaching was not a target of the change as such, but introducing bigger multidisciplinary courses basically require a team of teachers. Even if the implementation pattern was chosen by the teachers themselves, they were in varying degrees committed to it. The teachers in the third pattern (integrated module) were most enthusiastic, as they felt that they can learn a lot from others and that way increase their professional competence efficiently. However, co-teaching incorporates certain challenges in teamwork and also emotionally (Ulvelin 2015). As the English teachers of two paralleled modules reported, teaching together requires that one is able to pay attention to the other teacher, and gives up a personal lecturing mode (Paatola and Perälampi 2016).

Team teaching motifs framework (Wenger and Hornyak 1999) proved out to be a useful guide in distinguishing the alternative collaboration patterns of the teacher teams under study.

Slightly over 50% of the questions raised in Heads of degree program workshop dealt with leadership. This is not surprising, because the success of teamwork depends on how safe the team members feel in the team (Edmondson 2012), which is mostly a leadership issue. Management related questions were the second biggest category

(30%), which probably stems from the fact that teachers have a set number of working hours that is allocated to the courses they teach based on a model defined by the management. Themes of questions are spread more or less the same way across the target organizations with the exception of theme concern where lecturers had clearly larger share than other organisation units, which is not surprising as they are the party that are in the front line of team teaching implementation.

Purpose of this study was to answer the question: What should be taken into account when planning change from individual teaching model to teacher teams? According to the results, the transfer process could have been smoother, if the concerns (resourcing, loss of autonomy) that teachers had on team teaching, had been dealt up front. The whole teacher team should be on the same page with regard to learning targets, grading, implementation and integration.

In some course implementations, different subjects had been successfully integrated due to effective team teaching but in some cases, there had been no integration at all. Although there was also strong resistance toward team teaching among the faculty members, the teachers interviewed for this study believed that teacher collaboration and team teaching benefits both students and teachers. Their own experiences of team teaching had been mainly positive. Conflicts are likely to occur when new methods and practices are introduced. However, they should be seen as a normal phase when building productive teams. Few information sharing events on team teaching were organised, but more comprehensive training sessions might have helped the teacher teams to better integrate their efforts in planning and implementing the modules.

Based on the results, it seems that the change is a leadership challenge of answering to teacher concerns about the loss of autonomy and lack of time for planning

and preparing team teaching efforts. It requires a fundamental change of the way courses are planned and implemented. Furthermore, it requires effort from all persons involved. Based on the results, it looks like not all teacher teams adopt without guidance the collaboration patterns that would foster dialectic team teaching motif.

The study was done in one particular institution and all the results may not be transferable to other higher education institutions. However, similar changes are taking place in other Universities of Applied Sciences in Finland (Kunnari et al. in press) and in engineering education in general (Degraaf and Kolmos 2007) Two authors of this paper participated the teacher teams responsible for the courses, which may be good as the authors have first-hand experience and information. On the other hand, it means that personal bias cannot be ruled out in the analysis of data. Teacher workshop participation was roughly 30% of the teachers involved in team teaching, which means that the views expressed in the meetings may not fully reflect the views of the group of teachers as whole. The qualitative analysis methods used in this the study, do not cater for analysing fine-graded meaning of the talk or the type of language used. Thus**,** it is possible that some feelings, ideas, perceptions and attitudes remain unrevealed by the analysis.

Conclusions and further study

For the teachers involved, team teaching creates an opportunity to develop their teaching skills and helps teachers in forming a holistic understanding of subject matters and their relations. This comes at the expense of losing at least some of the teacher autonomy and requires development of teamwork skills. When planning the implementation of team teaching, it would be important to proactively address the worries of teachers like loss of autonomy and getting enough time and resources for

planning the courses. When a substantial change is made, like the one described in this study, it is of utmost importance that all levels of management are fully behind the idea and actively drive the implementation.

The results indicate that when teachers feel the new pedagogical approach and team teaching as rewarding experiences, they feel less concerned or apprehensive towards the educational reform. Sharing positive experiences with more reluctant colleagues hopefully encourages the sceptics to try out the new practices and start applying them.

This study examined the first year of curriculum change implementation; further study would be required to find out if the positive impact experienced in the first year translates to success in the later study years and whether the aim of providing students with 21st century skills would be met. Furthermore, it would be interesting to study teachers' experiences and perceptions after the team teaching model has been in use for few years. It could also make sense to investigate, if providing the newly formed teacher teams with help from a more experienced team teaching practitioner could help in smoothing the way towards team teaching.

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